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(54) **DRIVE SYSTEM FOR A UTILITY VEHICLE**

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F16H 37/06 (2006.01)

(57) **ABSTRACT**

A utility vehicle having a chassis frame extending along a centerline axis where the chassis frame includes a first side frame member and a second side frame member opposing one another about the centerline axis. A first drive mechanism is supported by the first frame member, and a second drive mechanism is supported by the second frame member. A first gearset assembly is coupled to the first drive mechanism, and a second gearset assembly is coupled to the second drive mechanism. A first axial flux electric motor is coupled to the first gearset and positioned between the first frame member and the first gearset, and a second axial flux electric motor is coupled to the second gearset and positioned between the second frame member and the second gearset. The first gearset and the second gearset are spaced apart from one another on opposite sides of the centerline axis thereby permitting each gearset assembly to be readily installed and maintained without interfering with the opposing gearset assembly.

(52) **U.S. Cl.**

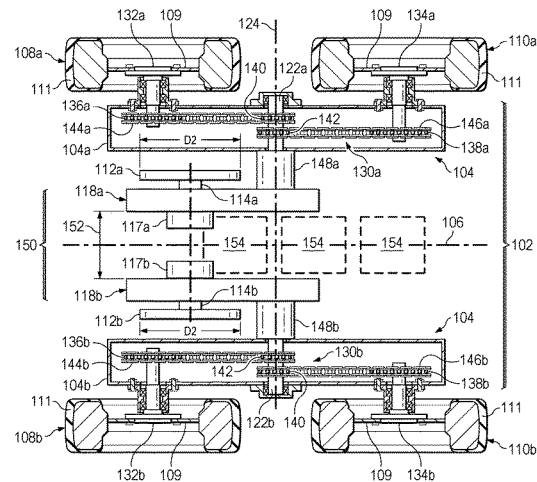
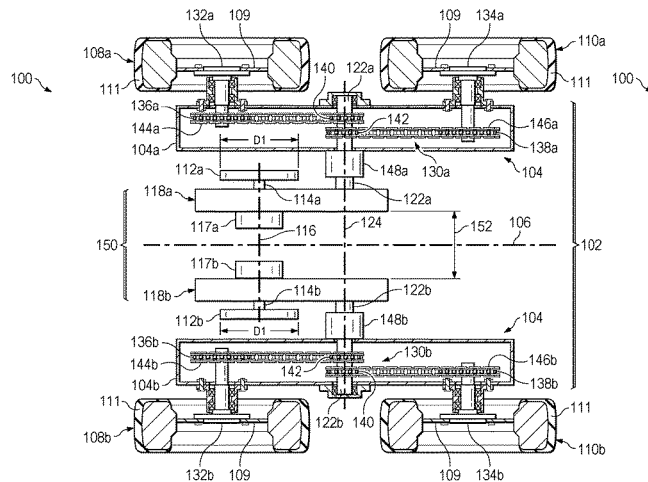
CPC **B60K 17/342** (2013.01); **B60K 1/02**
(2013.01); **B60K 1/04** (2013.01); **B60K 17/04**
(2013.01); **B60K 17/354** (2013.01); **B60K**
17/356 (2013.01); **F16H 37/065** (2013.01);
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See application file for complete search history.

18 Claims, 6 Drawing Sheets



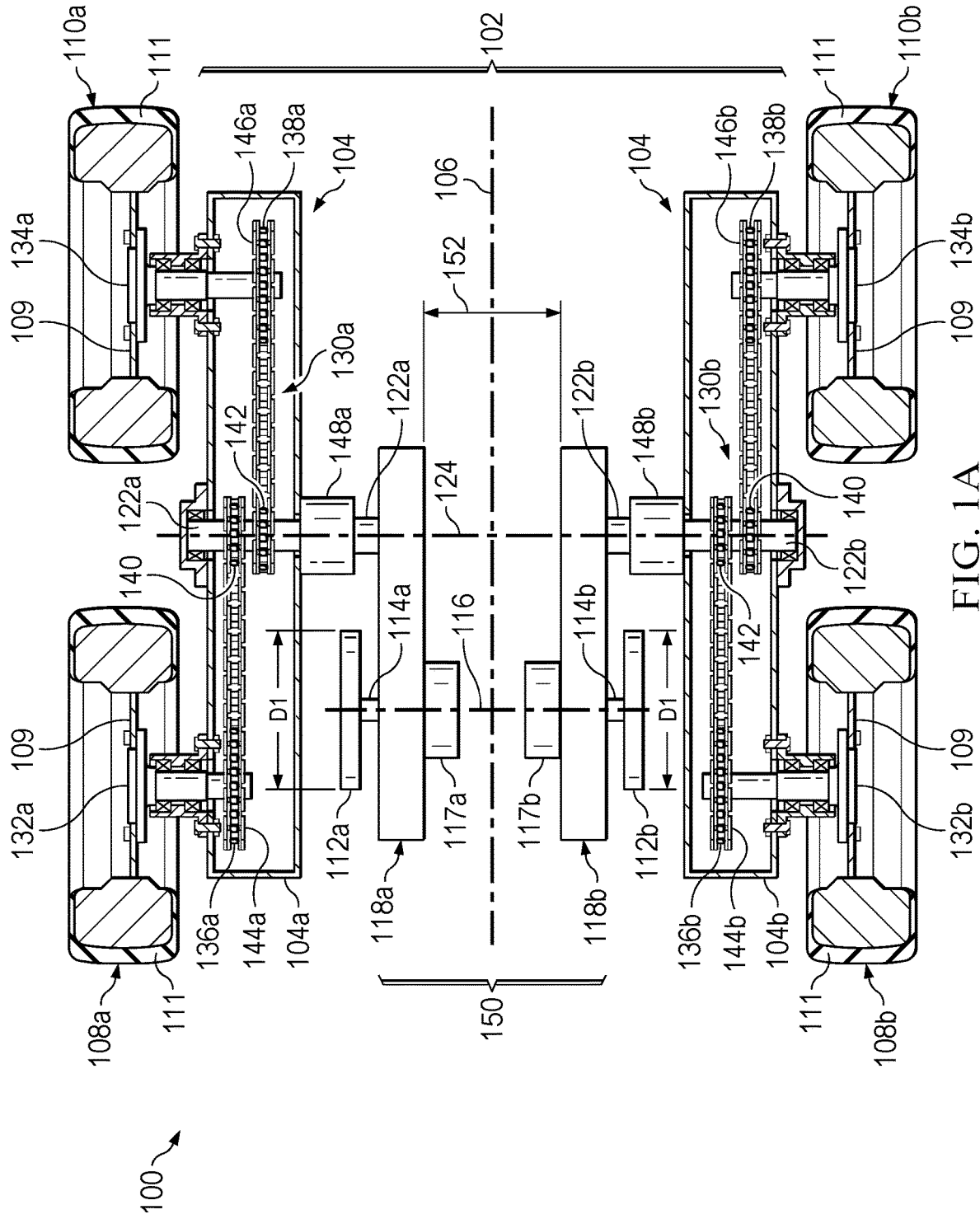
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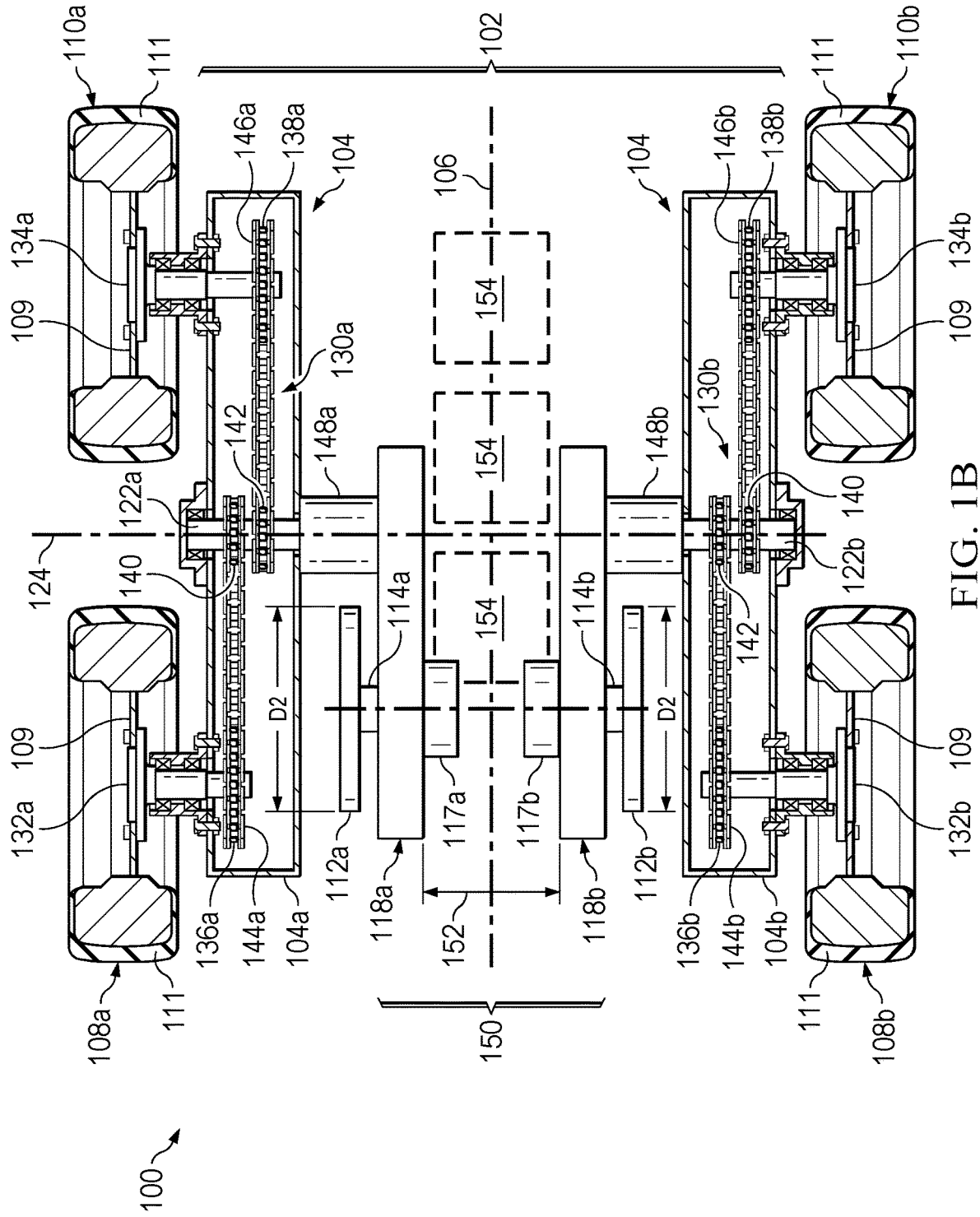


FIG. 1B

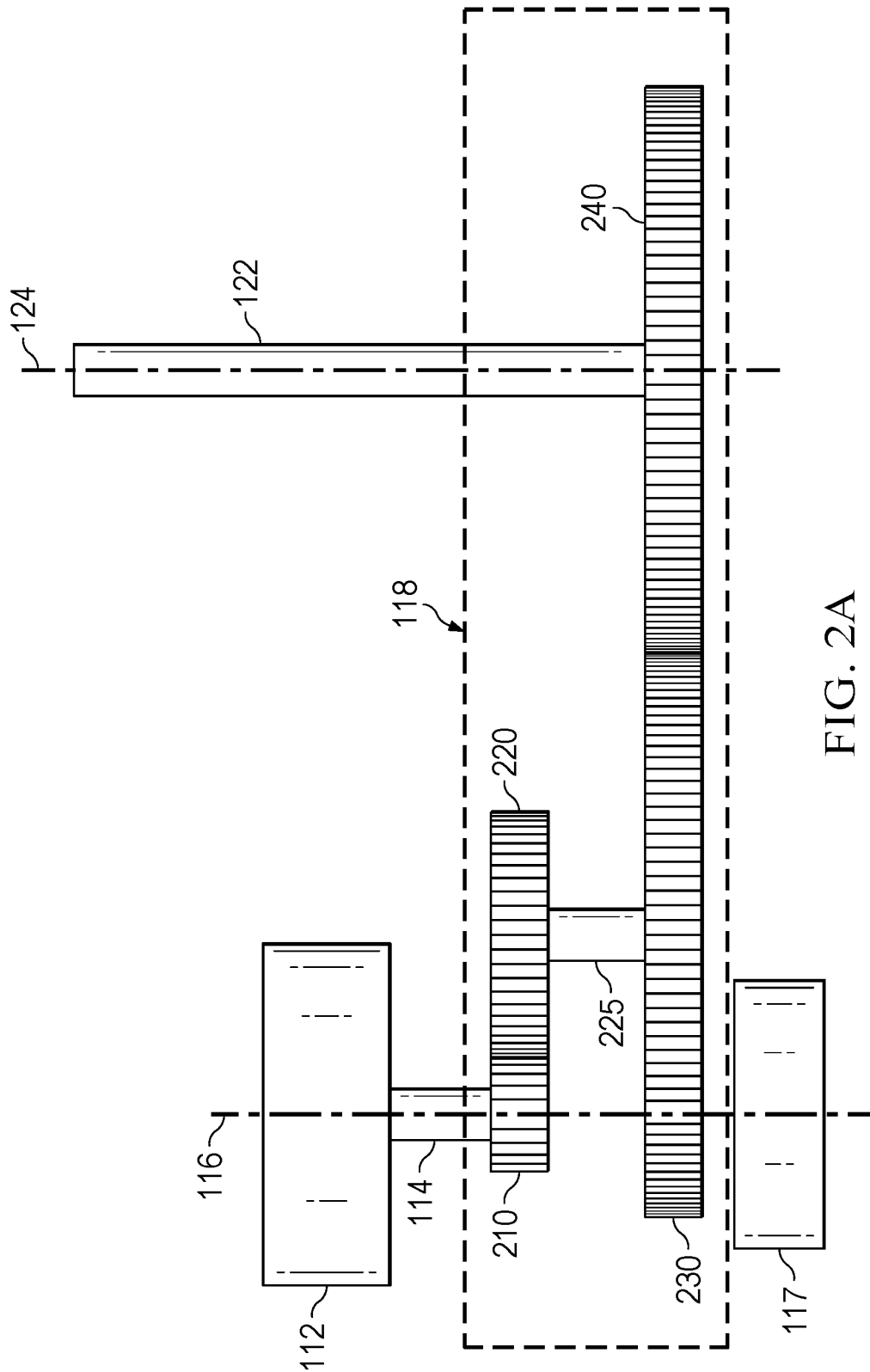


FIG. 2A

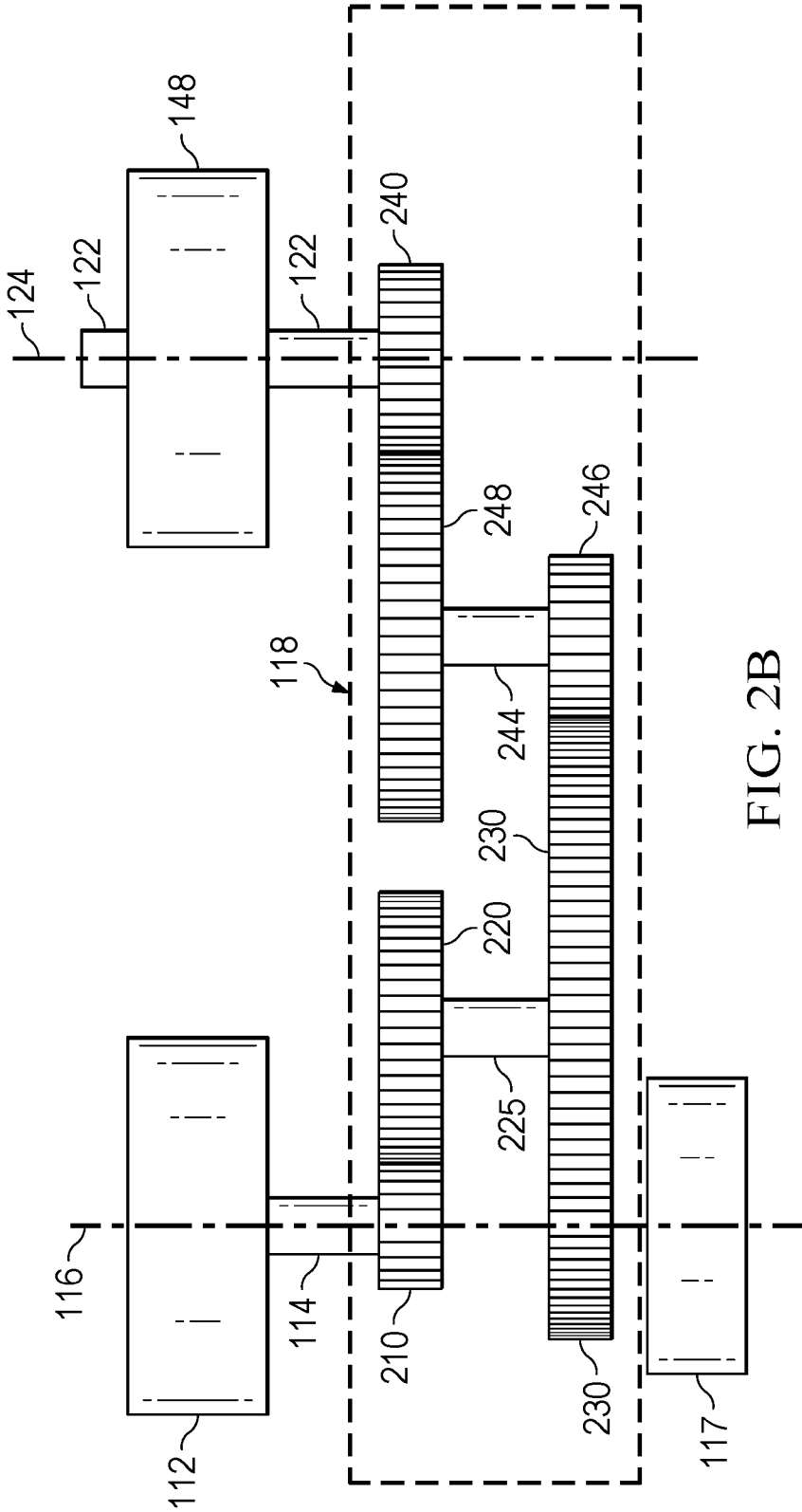


FIG. 2B

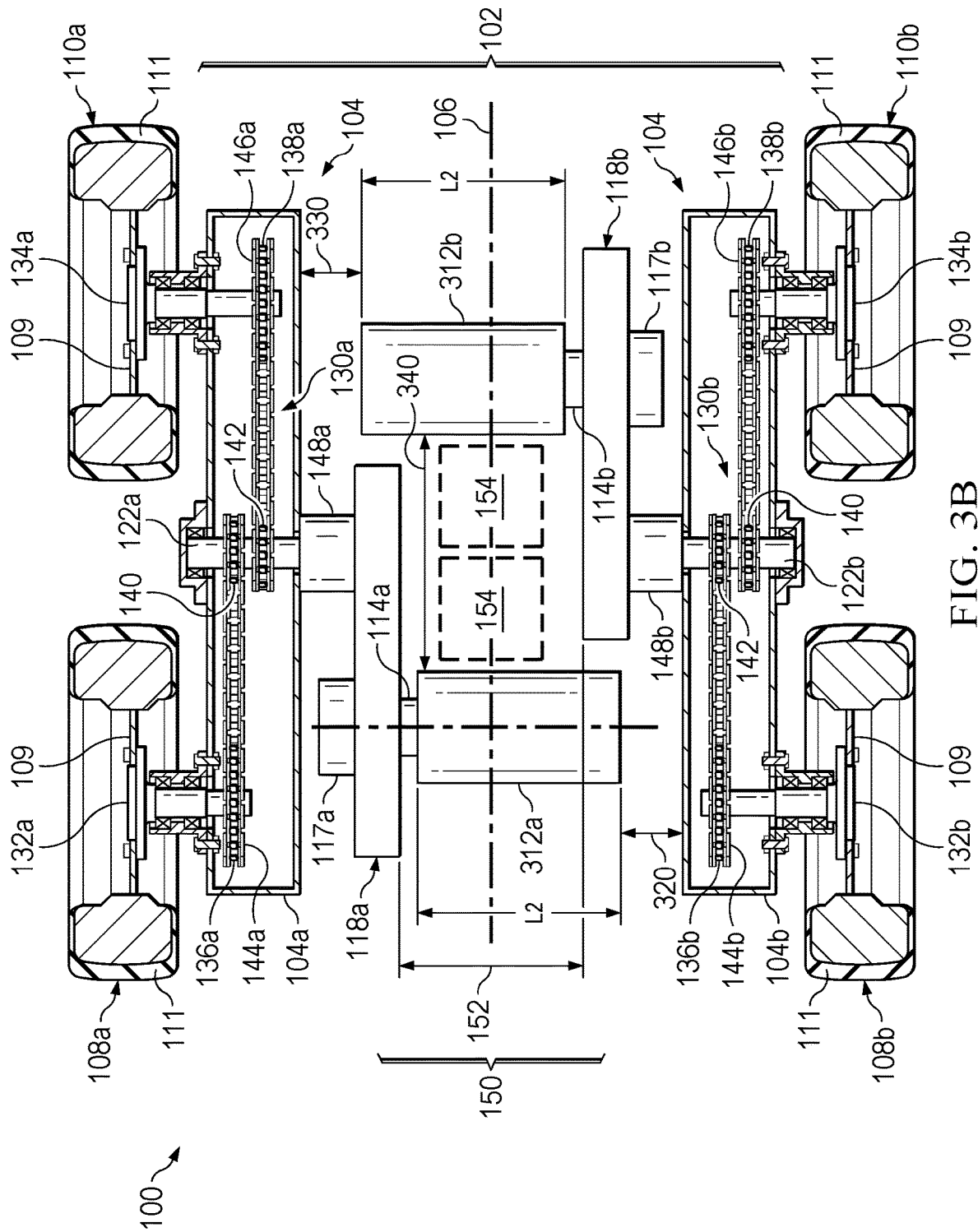


FIG. 3B

DRIVE SYSTEM FOR A UTILITY VEHICLE

FIELD

The disclosure relates to the field of utility vehicles, and in particular drive systems for electrically powered utility vehicles.

BACKGROUND

Existing drive systems for utility vehicles may include two centrally located motors positioned adjacent one another on a frame with each motor disposed to drive a set of wheels on opposing sides of the frame. Typically, planetary gearsets are utilized to achieve a desired gear reduction in order to drive the wheel sets. Moreover, it is known to position the two motors adjacent one another so that output drive shafts of the planetary gearsets are aligned along a shared axis at the middle of the frame in order to minimize the size of the drive train components so as to maximize the space available for batteries and controls. One drawback to such prior art arrangements is that the motor and gearing configuration renders installation, repair, and replacement of the motors difficult given the limited access space about the motors. In addition, given these space restraints, such systems do not lend themselves to ready replacement of motors with higher power motors having increased external dimensions.

BRIEF DESCRIPTIONS OF THE DRAWINGS

FIG. 1A is a top plan view of a utility vehicle including two axial flux electric motors positioned between respective gearset assemblies and respective side frame members according to some embodiments.

FIG. 1B is a top plan view of a utility vehicle including two axial flux electric motors positioned between respective gearset assemblies and respective side frame members according to some embodiments.

FIG. 2A illustrates a gearset assembly coupled to a motor according to some embodiments.

FIG. 2B illustrates a gearset assembly coupled to a motor according to some embodiments.

FIG. 3A is a top plan view of a utility vehicle including two radial flux electric motors spaced apart by a gap according to some embodiments.

FIG. 3B is a top plan view of a utility vehicle including two radial flux electric motors spaced apart by a gap according to some embodiments.

Various embodiments described herein and their advantages are described in the detailed description that follows. It should be appreciated that like reference numerals are used to identify like elements illustrated in the figure for purposes of illustrating but not limiting the various embodiments described herein.

DETAILED DESCRIPTION

Disclosed herein is an electric drive train system for a utility vehicle. The electric drive train system includes two axial flux electric motors, where each axial flux electric motor is disposed to drive the forward and rear wheels on a side of the utility vehicle. The axial flux electric motors are arranged on a vehicle chassis frame to be opposing but spaced apart from one another so as to define an access space between the opposing axial flux electric motors. In one or more first embodiments, each axial flux electric motor includes a driveshaft extending inwardly towards the oppos-

ing axial flux electric motor, where the driveshafts of the two axial flux electric motors may be aligned along a shared axis. In such first embodiments, each inwardly extending drive-shaft is coupled to a separate parallel shaft gearset assembly, where each parallel shaft gearset assembly may be positioned in the access space so as to be opposing but spaced apart from one another between the axial flux electric motors. In some embodiments, one or more electric batteries may be positioned in the access space between opposing parallel shaft gearset assemblies. Each parallel shaft gearset assembly includes an output shaft extending in a direction opposite the direction of the axial flux electric motor drive shaft to which it is coupled. In one or more embodiments, each output shaft of a parallel shaft gearset assembly is coupled to a chain drive mechanism which is in turn coupled to the forward wheel and the rear wheel of a side of the utility vehicle. The vehicle chassis frame extends along a centerline axis, where the chassis frame has opposing sides with a forward wheel and a rear wheel disposed on each side of the chassis frame. In some embodiments, the output shafts of the parallel shaft gearset assemblies may extend in opposite directions along the same output shaft axis. In some embodiments, the output shaft of a parallel shaft gearset assembly may be equidistant between the forward wheel and the rear wheel to which it is coupled. A brake assembly may be disposed along an output shaft coupled to the chain drive assembly. Likewise, a planetary gearset assembly may be disposed along an output shaft of a parallel shaft gearset assembly.

In one or more second embodiments, two electric drive motors are provided and spaced apart from one another longitudinally along a centerline axis of a utility vehicle chassis frame. Each drive motor is disposed to drive the forward and rear wheels on a side of the utility vehicle. Each drive motor includes a driveshaft extending outwards and engaged with a parallel shaft gearset assembly disposed along a respective side of the utility vehicle frame. Each parallel shaft gearset assembly includes an output shaft coupled to a chain drive mechanism which is in turn coupled to a forward wheel and a rear wheel. A brake assembly may be disposed along an output shaft coupled to the chain drive assembly. The parallel shaft gearset assembly as arranged in this second embodiment allows desired gear reductions to be achieved while minimizing the depth of the gearbox, thereby increasing the available lateral space for electric drive motors between the sides of the vehicle chassis frame. Because the motors are spaced apart longitudinally from one another, the access space therebetween can be utilized for batteries.

FIG. 1A is a top plan view of a utility vehicle **100** having an electric drive train system **102** supported on a vehicle chassis frame **104** extending along a centerline axis **106**. Vehicle chassis frame **104** includes opposing side frame members **104a**, **104b**. In one or more embodiments, each side frame member **104a**, **104b** includes at least a forward wheel assembly **108a**, **108b**, respectively, and a rear wheel assembly **110a**, **110b**, respectively. The electric drive train system **102** includes two axial flux electric motors **112**, namely a first axial flux electric motor **112a** and a second axial flux electric motor **112b**. Although not limited to a particular electric motor in some embodiments, in other embodiments, the axial flux electric motors **112a**, **112b** are alternating current motors. Although not limited to a particular type of axial flux electric motor, in one embodiment, one or more axial flux electric motor **112a**, **112b** may have two stators with a single rotor disposed therebetween so as to have a stator-rotor-stator arrangement. In other embodi-

ments, one or more axial flux electric motor **112a**, **112b** may have two rotors with a single stator disposed therebetween so as to have a rotor-stator-rotor arrangement. In any event, the two axial flux electric motors **112a**, **112b** are carried by vehicle chassis frame **104** so as to oppose one another on opposite sides of centerline axis **106**, but where the first axial flux electric motor **112a** is spaced apart from the second axial flux electric motor **112b** on opposite sides of centerline axis **106**. Moreover, each axial flux electric motor **112a**, **112b** includes a respective driveshaft **114a**, **114b** that extends inward from each respective axial flux electric motor **112a**, **112b** towards centerline axis **106**. In some embodiments, the driveshafts **114a**, **114b** of the respective axial flux electric motors **112a**, **112b** extend towards one another along the same driveshaft axis **116** such that driveshaft **114a** is coaxial with the driveshaft **114b**.

The utility vehicle **100** further includes two parallel shaft gearset assemblies **118a**, **118b**, where the gearset assemblies **118a**, **118b** are likewise disposed on opposing sides of a centerline axis **106**. Each gearset assembly **118a**, **118b** is coupled to a separate axial flux electric motor **112a**, **112b**, respectively. Moreover, each gearset assembly **118a**, **118b** is positioned inward of its respective axial flux electric motor **112a**, **112b** so that each gearset assembly **118a**, **118b** is positioned between the axial flux electric motor **112a**, **112b** to which it is coupled and the centerline axis **106**. Each gearset assembly **118a**, **118b** includes a respective output shaft **122a**, **122b** extending outward away from the centerline axis **106**. In one or more embodiments, the output shafts **122a**, **122b** of both gearset assemblies **118a**, **118b** are aligned along the same output shaft axis **124**.

As shown in FIG. 1A, each axial flux electric motor **112a**, **112b** is coupled to a respective gearset assembly **118a**, **118b** via a respective driveshaft **114a**, **114b** of each respective axial flux electric motor **112a**, **112b**. Thus, axial flux electric motor **112a** having driveshaft **114a** is coupled to gearset assembly **118a**, and axial flux electric motor **112b** having driveshaft **114b** is coupled to gearset assembly **118b**. Gearset assembly **118a** in turn drives an output shaft **122a**, which is used to rotate wheel assemblies **108a**, **10a** of the utility vehicle **100**, and gearset assembly **118b** in turn drives an output shaft **122b** which is used to rotate wheel assemblies **108b**, **110b** of utility vehicle **100**. As shown, output shafts **122a** and **122b** each extend outward from their respective gearset assemblies **118a**, **118b**, away from centerline axis **106**, such that they extend in a direction opposite the driveshafts **114a**, **114b** to which they are coupled.

Forward wheel assembly **108a** includes a wheel hub **109** on which is mounted a wheel **111**, while rear wheel assembly **110a** includes a wheel hub **109** on which is mounted a wheel **11**. Disposed along each side frame member **104a**, **104b** is a respective drive mechanism **130a**, **130b**. Each drive mechanism **130a**, **130b** includes a respective first wheel shaft **132a**, **132b** and a respective second wheel shaft **134a**, **134b**, where first wheel shafts **132a**, **132b** are respectively coupled to the wheel hubs **109** of the forward wheel assemblies **108a**, **108b**, and second wheel shafts **134a**, **134b** are respectively coupled to the wheel hub **109** of the rear wheel assemblies **110a**, **110b**. In one or more embodiments, a forward wheel sprocket **136a**, **136b** is formed as part of the wheel shafts **132a**, **132b**, respectively, or alternatively is separately affixed or attached to the wheel shafts **132a**, **132b**, respectively, for driving respective forward wheel assemblies **108a**, **108b**. Likewise, a rear wheel sprocket **138a**, **138b** is formed as part of wheel shafts **134a**, **134b**, respectively, or alternatively is separately affixed or attached to the

wheel shafts **134a**, **134b**, respectively, for driving respective rear wheel assemblies **110a**, **110b**.

While wheel assemblies **108a**, **108b**, **110a**, **11b** have been described with wheels **111**, in other embodiments, each wheel assembly may be a continuous track system having a continuous band of treads or track plates driven by two or more wheels or sprockets.

Each drive mechanism **130a**, **130b** also includes a first output sprocket **140** and a second output sprocket **142**, which output sprockets **140**, **142** are mounted on a respective output shaft **122a**, **122b** coupled to a respective gearset assembly **118a**, **118b**. The output sprockets **140**, **142** may be an integral part of the respective output shafts **122a**, **122b** or they may be separately attached to the respective output shafts **122a**, **122b**.

Finally, each drive mechanism **130a**, **130b** also includes a respective forward chain **144a**, **144b** and a respective rear chain **146a**, **146b**. Forward chains **144a**, **144b** engage respective forward wheel sprockets **136a**, **136b** and **140a**, **140b** and communicate horsepower and torque to respective forward wheel assemblies **108a**, **108b**. Rear chains **146a**, **146b** engage respective rear wheel sprockets **138a**, **138b** and **142a**, **142b** and communicate horsepower and torque to respective rear wheel assemblies **110a**, **110b**.

As used herein, sprocket refers to any wheel with cogs and chain may include any loop formed of links as well as any smooth or cogged belts or other flexible looped mechanism.

In one or more embodiments, a regulator assembly **148a**, **148b** may be disposed along the output shaft **122a**, **122b**, respectively, extending from respective gearset assemblies **118a**, **118b**. In some embodiments, the regulator assemblies **148a**, **148b** may be integrally formed with or alternatively coupled to the output shaft **122a**, **122b**, respectively. In one or more embodiments, regulator assemblies **148a**, **148b** may be a brake as is well known in the art, which may include an electric brake, a hydraulic brake or a mechanical brake. In other embodiments, regulator assemblies **148a**, **148b** may be a planetary gearset.

As discussed above, each axial flux electric motor **112a**, **112b** is positioned between a respective gearset assembly **118a**, **118b** and its respective side frame member **104a**, **104b**. By positioning the axial flux electric motors **112a**, **112b** at an outward location relative to centerline axis **106** with their respective driveshafts **114a**, **114b** extending back towards centerline axis **106**, an access space **150** between the axial flux electric motors **112a**, **112b** is formed. The access space **150** allows the gearset assemblies **118a**, **118b** to be more readily installed during manufacture of the utility vehicle **100**, and allows the gearset assemblies **118a**, **118b** to be more readily accessed for maintenance. Additionally, when installed the gearset assemblies **118a**, **118b** are also spaced apart by a gap **152**. As shown in FIG. 1A, the gap **152** spans across the centerline axis **106** of the utility vehicle **100**. Because the utility vehicle **100** includes the gap **152** between the gearset assemblies **118a**, **118b**, the electric drive train system **102** of the utility vehicle **100** may be more easily manufactured. The gap **152** allows for tools (e.g., drills, wrenches, etc.) or people to access the interior of the utility vehicle **100** when installing or maintaining the components of the electric drive train system **102** of the utility vehicle **100**. For example, gearset assemblies **118a**, **118b** may be inserted into the access space **150** of utility vehicle **100** without interfering with one another.

As is best seen in FIG. 1B, in one or more embodiments, one or more batteries **154** may be installed in the gap **152** between gearset assemblies **118a**, **118b**. The opposing gear-

set assemblies **118a**, **118b**, being spaced apart from one another to form gap **152**, provide sufficient space for batteries **154** to be installed along centerline axis **106**.

As noted above, in one or more embodiments, output shafts **122a**, **122b** are aligned along output shaft axis **124**. Moreover, in some embodiments, output shaft axis **124** is arranged to be approximately equidistant between wheel shafts **132a**, **134a** and approximately equidistant between wheel shafts **132b**, **134b**. As such, aligning the output shafts **122a**, **122b** may allow for the weight distribution of the utility vehicle **100** to be more evenly balanced. Balancing the weight distribution of the components of the utility vehicle **100** may result in a more even torque distribution to the wheel assemblies **108a**, **108b**, **110a**, **110b**. In this regard, in those embodiments where batteries **154** are installed in the gap **152** between opposing gearset assemblies **118a**, **118b**, the position of the batteries **154** may likewise be specifically selected to achieve a desired weight distribution. In some embodiments, the batteries **154** may be symmetrically deployed about output shaft axis **124** thus evenly distributing the weight of batteries **154** about output shaft axis **124**. In other embodiments, as desired, the batteries **154** may be positioned forward or rearward of output shaft axis **124** to achieve a particular weight distribution. For example, in the illustrated embodiment, the axial flux electric motors **112a**, **112b**, and gearset assemblies **118a**, **118b** are positioned primarily forward of output shaft axis **124**, and the batteries **154** are positioned so that their collective weight is primarily rearward of output shaft axis **124**.

Notably, where output shafts **122a**, **122b** may each be placed at the center of their respective side frame members **104a**, **104b**, the lengths of the chains **144a**, **146a**, **144b**, **146b** may be the same. This allows for the drive system to be more easily assembled because any one of the four chains **144a**, **146a**, **144b**, **146b**, can be used in any of the four locations where the chains are to be located.

The power output of an axial flux motor increases as a diameter of the axial flux motor increases. For example, as shown in FIG. 1A, the axial flux electric motors **112a**, **112b** each have a diameter D1. FIG. 1B illustrates axial flux electric motors **112a**, **112b** each having a diameter D2. The diameter D2 is greater than the diameter D1. Therefore, the axial flux electric motors **112a**, **112b** shown in FIG. 1B output more power than the axial flux electric motors **112a**, **112b** shown in FIG. 1A. While the diameters of the axial flux electric motors **112a**, **112b** may change, the axial thickness of the motors may remain the same, thereby permitting the motors to be arranged as described above while permitting flexibility to change the power output of the motors. For example, the axial flux electric motors **112a**, **112b** of FIG. 1A have the same axial thickness as the axial flux electric motors **112a**, **112b** of FIG. 1B. Therefore, the power output of the motors may be increased by increasing the diameter of the motors without increasing the axial thickness of the motors or encroaching on the access space **150**. This allows for more powerful motors to be installed in the utility vehicle **100** without reducing the space provided by the gap **152** between the gearset assemblies **118a**, **118b**.

Although axial flux electric motors **112a**, **112b**, as well as gearset assemblies **118a**, **118b** are shown as opposing or mirroring one another across centerline axis **106** in order to define gap **152** therebetween, it will be appreciated that in other embodiments, one axial flux electric motor, such as axial flux electric motor **112a**, may be forward of output shaft axis **124**, and one axial flux electric motor, such as axial flux electric motor **112b**, may be rearward of output shaft axis **124**, whereby the access space **150** is maintained,

and thereby allowing the gap **152** between gearset assemblies **118a**, **118b** to be established. It will be appreciated that in such case, driveshafts **114a**, **114b** do not extend along the same axis, but in any case, each driveshaft **114a**, **114b** still extends inward towards centerline axis **106**.

In one or more embodiments, a brake **117** may be disposed to control rotation of driveshaft **114**. In some embodiments, brake **117** is disposed along driveshaft axis **116**. In some embodiments, brake **117** is mounted on gearbox assembly **118** opposite the axial flux electric motor **112**. Thus, in FIGS. 1A and 1B, brake **117a** is shown mounted on gearbox assembly **118a** opposite axial flux electric motor **112a**, and brake **117b** is shown mounted on gearbox assembly **118b** opposite axial flux electric motor **112b** along driveshaft axis **116**. Although not limited to a type of brake, in one or more embodiments, brake **117** may be an electromagnetic brake. In still other embodiments, brake **117** may be a hydraulic brake.

FIGS. 2A and 2B illustrate exemplary configurations of a gearset assembly **118**. The gearset assembly **118** may represent one or both of gearset assemblies **118a**, **118b**. The gearset assembly **118** shown in FIGS. 2A and 2B is a parallel shaft gearset assembly. In that regard, the driveshaft **114** (e.g., driveshaft **114a**, **114b**) of the axial flux electric motor **112** (e.g., axial flux electric motor **112a**, **112b**) is parallel or substantially parallel with the output shaft **122** (e.g., the output shaft **122a**, **122b**), as well as any intermediate shafts coupled thereto. In FIG. 2A, the gearset assembly **118** includes an input gear **210** mounted on the driveshaft **114** and meshed with a first intermediate gear **220**. First intermediate gear **220** is mounted on a first intermediate driveshaft **225**, on which is also mounted a second intermediate gear **230** so that actuation of axial flux electric motor **112** results in rotation of second intermediate gears **230**. Meshed with second intermediate gear **230** is an output gear **240** mounted on output shaft **122** extending along output shaft axis **124**. Any one or more of the gears **210**, **220**, **230**, **240** may be spur gears or alternatively may be any other type of gear, such as a helical gear, a planetary gear or gear set, a worm gear, a bevel gear, etc. In one or more embodiments, the output gear **240** may be a planetary gear set. In one or more embodiments, gears **230** and **240** may be the same diameter, which is larger than the diameters of gears **210** and **220**, as illustrated. FIG. 2B is similar to FIG. 2A, but includes an additional intermediate driveshaft **244** with additional intervening intermediate gears **246** and **248** mounted thereon, wherein additional intermediate driveshaft **244** is parallel with shafts **114**, **225**, and **122**. In one or more embodiments, gears **248** may be larger in diameter than gear **240**, and gear **230** may be larger in diameter than gear **246**, as illustrated. Notwithstanding the foregoing, it will be appreciated that in other embodiments, gear diameters may be selected to achieve a desired gearing ratio for driving output shaft **122**.

In FIG. 2B, a regulator assembly **148** (e.g., regulator assembly **148a**, **148b**) may be disposed along output shaft **122**. In one or more embodiments, regulator assembly **148** may be a brake, while in other embodiments, regulator assembly **148** may be a planetary gearset.

Although not required, in some embodiments, such as is shown in FIGS. 2A and 2B, a brake **117** may be disposed to control rotation of driveshaft **114**. In some embodiments, brake **117** is disposed along driveshaft axis **116**. In some embodiments, brake **117** is mounted on gearbox assembly **118** opposite the axial flux electric motor **112**.

Turning to FIGS. 3A and 3B, other embodiments of a utility vehicle **100** are illustrated, wherein radial flux electric

motors **312a**, **312b** are utilized to power utility vehicle **100**. Although not limited to a particular electric motor in some embodiments, in other embodiments, the radial flux electric motors **312a**, **312b** are alternating current motors. As shown in FIG. 3A, the radial flux electric motors **312a**, **312b** are in a spaced apart, staggered configuration along centerline axis **106** so as to provide the access space **150** and gap **152** along centerline axis **106**. The radial flux electric motor **312a** is positioned at the forward end of the utility vehicle **100**, and the radial flux electric motor **312b** is positioned at the rear end of the utility vehicle **100**. Each radial flux electric motor **312a**, **312b** is coupled to a respective gearset assembly **118a**, **118b** via a respective driveshaft **114a**, **114b**. As described above with respect to FIGS. 1A and 1B, the access space **150** and gap **152** permit ease of assembly and maintenance of electric drive train system **102**.

In the embodiments of FIGS. 3A and 3B, gearset assembly **118a** is positioned between the radial flux electric motor **312a** and the side frame member **104a**. Similarly, the gearset assembly **118b** is positioned between the radial flux electric motor **312b** and the side frame member **104b**. By positioning the gearset assemblies **118a**, **118b** in these positions, the driveshafts **114a**, **114b** of radial flux electric motors **312a**, **312b**, respectively, extend away from the centerline axis **106** of the utility vehicle **100**. Additionally, as shown in FIG. 3A, the radial flux electric motor **312a** is spaced apart from the side frame member **104b** by a gap **320**. Similarly, the radial flux electric motor **312b** is spaced apart from the side frame member **104a** by a gap **330**. The gaps **320**, **330** extend in a direction that is generally perpendicular to the centerline axis **106** of the utility vehicle **100**. The gap **320** and the gap **330** may be the same length or may be different lengths. The gaps **320**, **330** may be different lengths if the radial flux electric motors **312a**, **312b** are different sizes. Additionally, the radial flux electric motors **312a**, **312b** are spaced apart from each other by a gap **340**, which spans along the centerline axis **106** of the utility vehicle **100**. In that regard, the gap **340** spans in a direction generally parallel with the centerline axis **106**, such that gap **152** and gap **340** at least partially define the access space **150**.

The gaps **152**, **320**, **330**, **340** allow for tools (e.g., drills, wrenches, etc.) or people to access the interior of the utility vehicle **100** when installing or maintaining the components of the electric drive train system **102** of the utility vehicle **100**. For example, the gearset assemblies **118a**, **118b** and the radial flux electric motors **312a**, **312b** may be inserted into the utility vehicle **100** and coupled to their respective side frame members **104a**, **104b**. The gaps **320**, **330** provide clearance space between the gearset assemblies **118a**, **118b** and the side frame members **104a**, **104b**, respectively, to reduce the probability of interference between components.

As discussed above with respect to FIG. 1B, in one or more embodiments as shown in FIG. 3B, one or more batteries **154** may be installed in the access space **150** formed by gaps **152**, **340** between gearset assemblies **118a**, **118b**. The opposing gearset assemblies **118a**, **118b**, being spaced apart from one another to form gap **152** and the opposing radial flux electric motors **312a**, **312b**, being spaced apart from one another to form gap **340**, provide sufficient space for batteries **154** to be installed along centerline axis **106**.

As discussed above, the motors **312a**, **312b** may be radial flux electric motors in some embodiments. In other embodiments, the motors **312a**, **312b** may be hydraulic motors. However, it will be appreciated that because axial flux motors typically require larger diameters than radial flux motors, axial flux motors would not be suitable for the

embodiments of the vehicle shown in FIGS. 3A and 3B because the access space **150** as defined by gaps **152** and **340** could not be established. In any event, the power output of a radial flux electric motor increases as a length of the radial flux electric motor increases. For example, as shown in FIG. 3A, the radial flux electric motors **312a**, **312b** each have a length **L1**. FIG. 3B illustrates radial flux electric motors **312a**, **312b** each having a length **L2**. The length **L2** is greater than the length **L1**. Therefore, the radial flux electric motors **312a**, **312b** shown in FIG. 3B output more power than the radial flux electric motors **312a**, **312b** shown in FIG. 3A. While the lengths of the radial flux electric motors **312a**, **312b**, may change, the diameter (or width) of the motors may remain the same (as opposed to axial flux motors with where power output increases with diameter). Therefore, the power output of the radial flux electric motors **312a**, **312b** may be increased by increasing the length of the radial flux electric motors **312a**, **312b** without increasing the diameter of the radial flux electric motors **312a**, **312b**. This allows for more powerful motors to be installed in the utility vehicle **100** without reducing the access space **150** defined by gaps **152** and **340**. In some alternative embodiments, the width of the individual radial flux electric motors **312a**, **312b** may also vary.

As shown in FIG. 3B, because the radial flux electric motors **312a**, **312b** are longer than the radial flux electric motors **312a**, **312b** of FIG. 3A, the gaps **320**, **330** are smaller than in FIG. 3A. Having the gaps **320**, **330** allows for motors of varying size to be easily placed and/or swapped out within the utility vehicle **100**.

In one or more embodiments, a brake **117** may be disposed to control rotation of driveshaft **114**. In some embodiments, brake **117** is mounted on gearbox assembly **118** opposite the radial flux electric motor **312**. Thus, in FIGS. 3A and 3B, brake **117a** is shown mounted on gearbox assembly **118a** opposite radial flux electric motor **312a**, and brake **117b** is shown mounted on gearbox assembly **118b** opposite radial flux electric motor **312b**.

While certain embodiments of the present disclosure have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive to the broad disclosed concepts, and that the embodiments of the present disclosure not be limited to the specific constructions and arrangements shown and described, since various other modifications may occur to those ordinarily skilled in the art.

What is claimed is:

1. A utility vehicle comprising:

- a vehicle chassis frame extending along a centerline axis, the vehicle chassis frame having a first side frame member and a second side frame member opposing one another about the centerline axis;
- a first drive mechanism supported by the first side frame member and coupled to a first forward wheel assembly and a first rear wheel assembly disposed along the first side frame member; and
- a second drive mechanism supported by the second side frame member and coupled to a first forward wheel assembly and a first rear wheel assembly disposed along the second side frame member;
- a first gearset assembly including an output shaft coupled to the first drive mechanism;
- a second gearset assembly including an output shaft coupled to the second drive mechanism;
- a first axial flux electric motor coupled to the first gearset assembly and positioned between the first side frame member and the first gearset assembly; and

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a second axial flux electric motor coupled to the second gearset assembly and positioned between the second side frame member and the second gearset assembly, wherein the first gearset assembly and the second gearset assembly are spaced apart from one another on opposite sides of the centerline axis.

2. The utility vehicle of claim 1, wherein the first axial flux electric motor has a driveshaft extending inwardly towards the centerline axis and wherein the second axial flux electric motor has a driveshaft extending inwardly towards the centerline axis.

3. The utility vehicle of claim 2, wherein the driveshaft of the first axial flux electric motor is coaxial with the driveshaft of the second axial flux electric motor.

4. The utility vehicle of claim 1, wherein each of the first and second drive mechanisms comprise:

a first wheel shaft coupled to a forward wheel assembly;
a second wheel shaft coupled to a rear wheel assembly;
a forward wheel sprocket disposed on the first wheel shaft;

a rear wheel sprocket disposed on the second wheel shaft;
a first output sprocket disposed on the output shaft of the respective first and second gearset assemblies;
a second output sprocket disposed on the output shaft of the respective first and second gearset assemblies;

a forward chain engaging the forward wheel sprocket and the first output sprocket; and
a rear chain engaging the rear wheel sprocket and the second output sprocket.

5. The utility vehicle of claim 1, wherein the first gearset assembly and the second gearset assembly are each a parallel shaft gearset assembly.

6. The utility vehicle of claim 1, further comprising a brake disposed along an output shaft of one of the first and second gearset assemblies.

7. The utility vehicle of claim 1, wherein the first gearset assembly comprises:

an input gear mounted on a driveshaft of the first axial flux electric motor;

a first intermediate gear mounted on an intermediate driveshaft and meshed with the input gear;

a second intermediate gear mounted on the intermediate driveshaft; and

an output gear mounted on the output shaft and meshed with the second intermediate gear.

8. The utility vehicle of claim 1, wherein the spaced apart first and second gearset assemblies define a gap therebetween, the utility vehicle further comprising at least one battery disposed in the gap formed between the first gearset assembly and the second gearset assembly.

9. The utility vehicle of claim 1, wherein the first axial flux electric motor is an alternating current motor, and wherein the second axial flux electric motor is an alternating current motor.

10. A utility vehicle comprising:

a vehicle chassis frame extending along a centerline axis, the vehicle chassis frame having a first side frame member and a second side frame member opposing one another about the centerline axis;

a first forward wheel assembly and a first rear wheel assembly disposed along the first side frame member;

a second forward wheel assembly and a second rear wheel assembly disposed along the second side frame member;

a first gearset assembly supported by the first side frame member, the first gearset assembly including an output shaft;

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a first drive mechanism supported by the first side frame member, the first drive mechanism comprising:

a first wheel shaft coupled the first forward wheel assembly;

a second wheel shaft coupled to the first rear wheel assembly;

a forward wheel sprocket disposed on the first wheel shaft of the first drive mechanism;

a rear wheel sprocket disposed on the second wheel shaft of the first drive mechanism;

a first output sprocket disposed on the output shaft of the first gearset assembly; and

a second output sprocket disposed on the output shaft of the first gearset assembly;

a second gearset assembly supported by the second side frame member, the second gearset assembly including an output shaft;

a second drive mechanism supported by the second side frame member, the second drive mechanism comprising:

a first wheel shaft coupled the second forward wheel assembly;

a second wheel shaft coupled to the second rear wheel assembly;

a forward wheel sprocket disposed on the first wheel shaft of the second drive mechanism;

a rear wheel sprocket disposed on the second wheel shaft of the second drive mechanism;

a first output sprocket disposed on the output shaft of the second gearset assembly; and

a second output sprocket disposed on the output shaft of the second gearset assembly;

a first axial flux electric motor positioned between the first side frame member and the first gearset assembly, the first axial flux electric motor having a driveshaft extending towards the centerline axis and coupled to the first gearset assembly; and

a second axial flux electric motor positioned between the second side frame member and the second gearset assembly, the second axial flux electric motor having a driveshaft extending towards the centerline axis and coupled to the second gearset assembly,

wherein the first gearset assembly and the second gearset assembly are spaced apart from one another on opposite sides of the centerline axis to define a gap between the first and second gearset assemblies.

11. The utility vehicle of claim 10, wherein the driveshaft of the first axial flux electric motor is coaxial with the driveshaft of the second axial flux electric motor.

12. The utility vehicle of claim 10, wherein the first gearset assembly and the second gearset assembly are each a parallel shaft gearset assembly.

13. The utility vehicle of claim 12, wherein:

the first gearset assembly comprises:

an input gear mounted on the driveshaft of the first axial flux electric motor;

an output gear mounted on the output shaft of the first gearset assembly;

a first intermediate gear mounted on an intermediate driveshaft and meshed with the input gear of the driveshaft of the first axial flux electric motor; and
a second intermediate gear mounted on the intermediate driveshaft and meshed with the output gear

mounted on the output shaft of the first gearset assembly; and

the second gearset assembly comprises:

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an input gear mounted on the driveshaft of the second axial flux electric motor;
 an output gear mounted on the output shaft of the second gearset assembly;
 a first intermediate gear mounted on an intermediate driveshaft and meshed with the input gear of the driveshaft of the second axial flux electric motor; and
 a second intermediate gear mounted on the intermediate driveshaft and meshed with the output gear mounted on the output shaft of the second gearset assembly.

14. The utility vehicle of claim 10, further comprising a brake disposed along the output shaft or the input shaft of one of the first and second gearset assemblies.

15. The utility vehicle of claim 10, wherein the first gearset assembly and the second gearset assembly are spaced apart from one another on opposite sides of the centerline axis to define an access space therebetween.

16. The utility vehicle of claim 15, further comprising at least two electric batteries disposed in the access space between the first and second gearset assemblies.

17. The utility vehicle of claim 16, wherein the output shafts of the first and second axial flux electric motors extend along an output shaft axis, and wherein the first and second axial flux electric motors are positioned on one side of the output shaft axis and the electric batteries are positioned primarily on the other side of the output shaft axis.

18. A utility vehicle comprising:

a vehicle chassis frame extending along a centerline axis, the vehicle chassis frame having a first side frame member and a second side frame member opposing one another about the centerline axis;

a first drive mechanism supported by the first side frame member and coupled to a wheel assembly disposed along the first side frame member; and

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a second drive mechanism supported by the second side frame member and coupled to a wheel assembly disposed along the second side frame member;

a first gearset assembly including an output shaft extending along an output shaft axis, the output shaft of the first gearset assembly coupled to the first drive mechanism, the first gearset assembly spaced apart from the centerline axis, wherein the first gearset assembly is a parallel shaft gearset assembly;

a second gearset assembly including an output shaft extending along the output shaft axis, the output shaft of the second gearset assembly coupled to the second drive mechanism, the second gearset assembly spaced apart from the centerline axis and opposing the first gearset assembly to define a first gap therebetween, wherein the second gearset assembly is a parallel shaft gearset assembly;

a first radial flux electric motor coupled to the first gearset assembly on a first side of the output shaft axis, the first radial flux electric motor extending across the centerline axis towards the second side frame member;

a second radial flux electric motor coupled to the second gearset assembly on a second side of the output shaft axis, the second radial flux electric motor extending across the centerline axis towards the first side frame member, the first and second radial flux electric motors spaced apart from one another about the output shaft axis so as to define a second gap between the first and second radial flux electric motors; and

at least one electric battery disposed in the gap between the first and second radial flux electric motors.

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